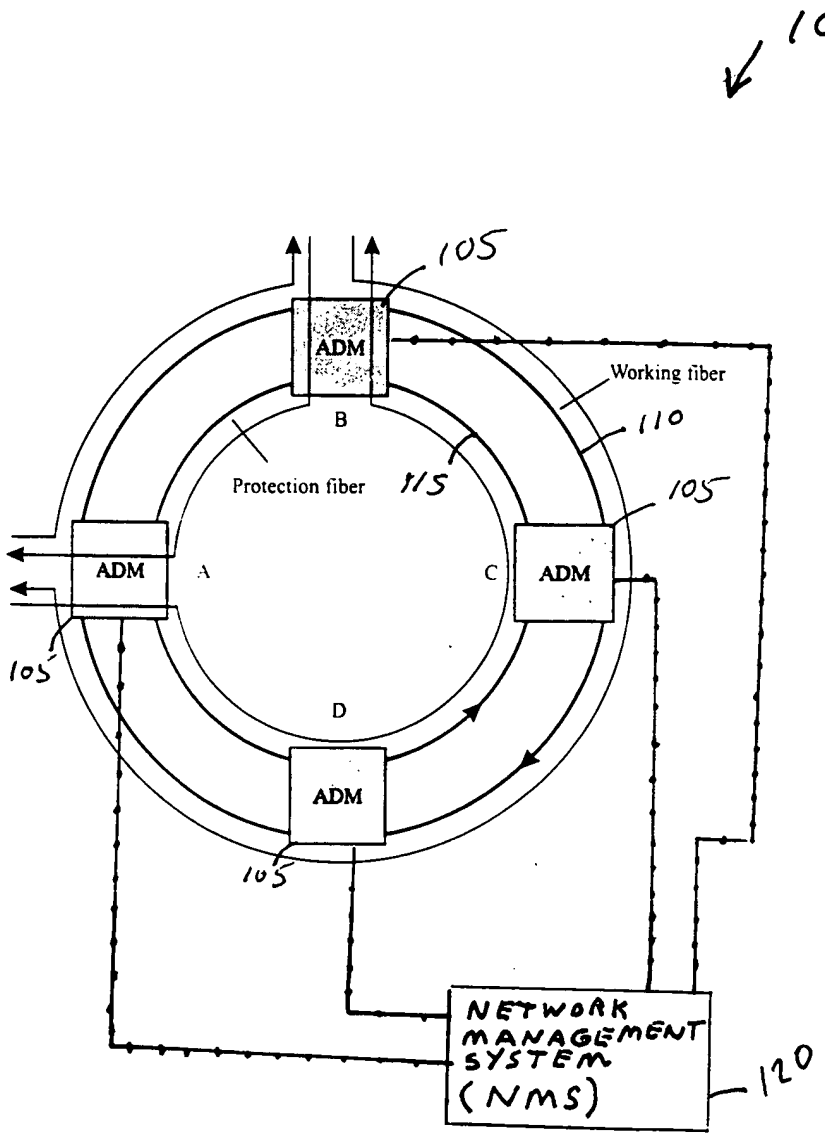

FIG. 1 (prior art)

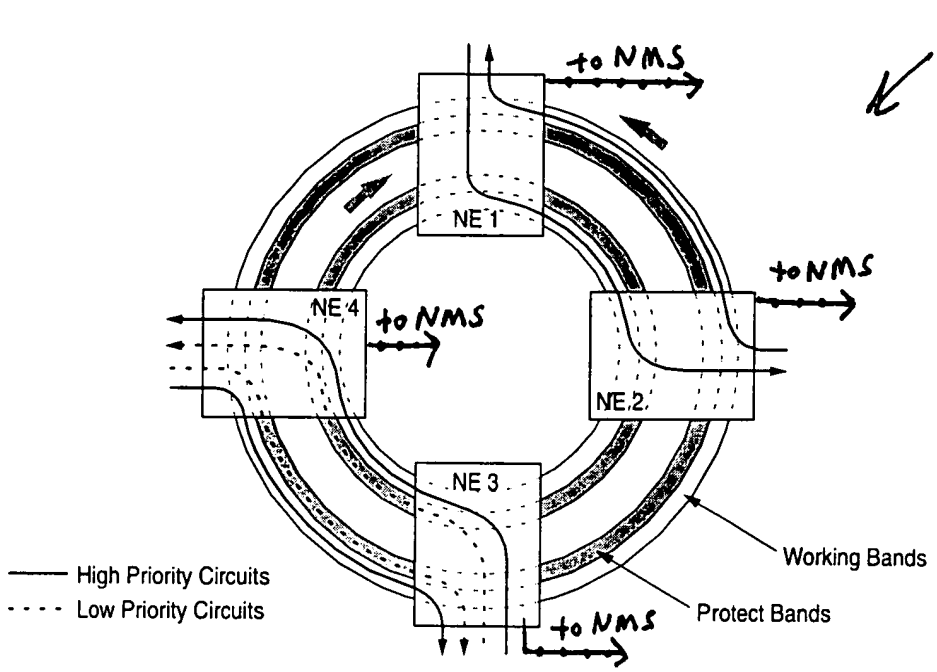

FIG. 2 (prior art)

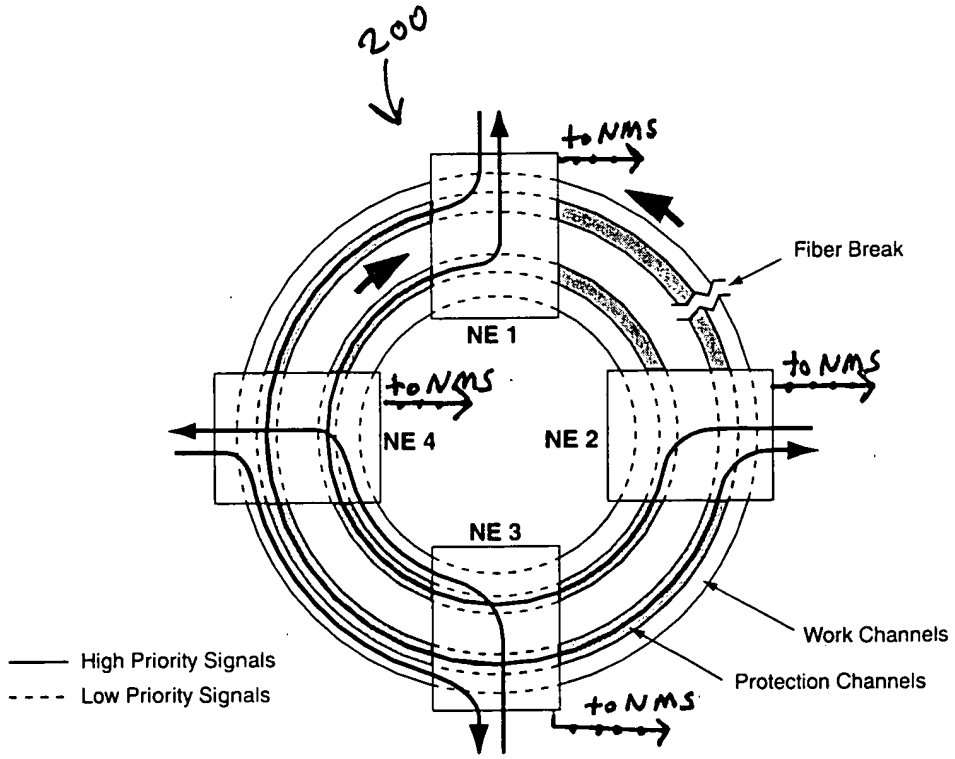

FIG. 3 (prior art)

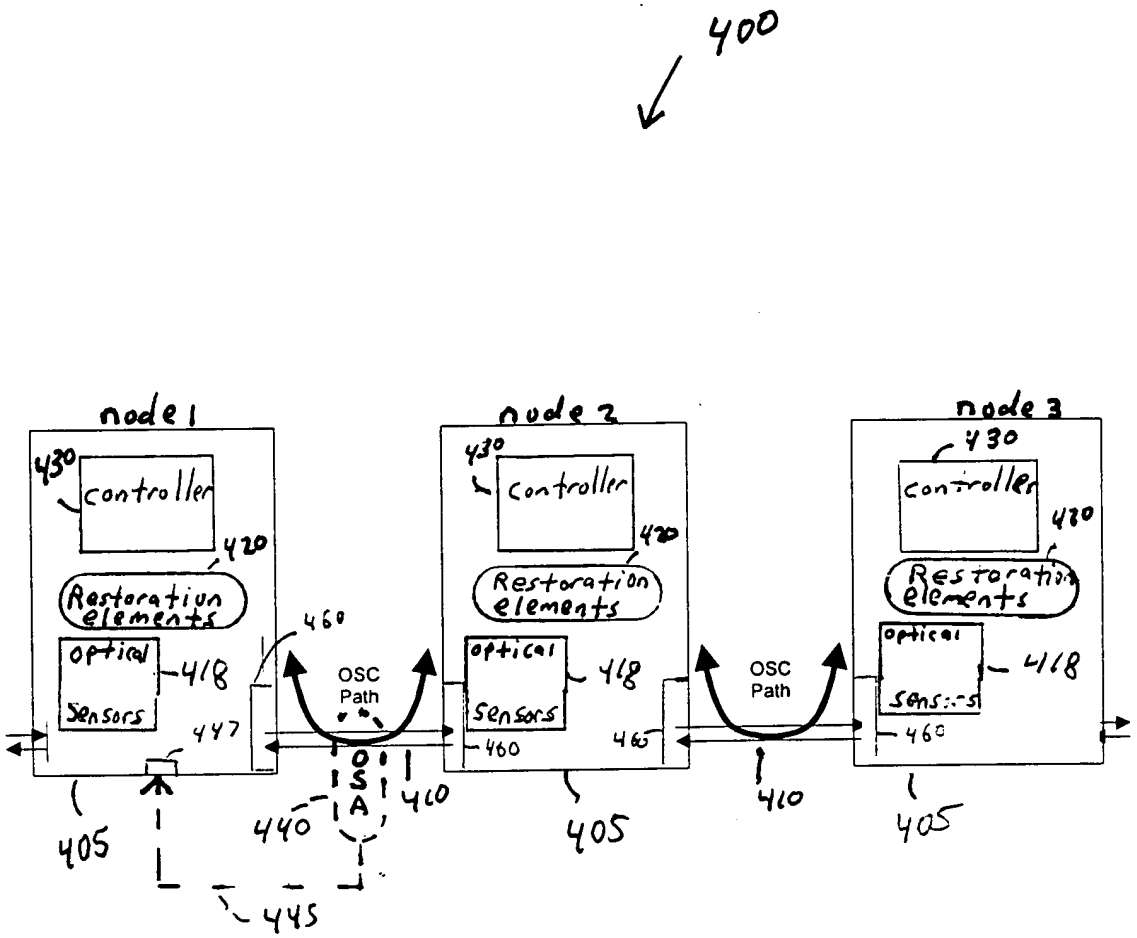
400
node 1
node 2
node 3
430
controller
420
Restoration elements
optical sensors
418
460
OSC Path
447
405
440
OSA
410
445

FIG. 4

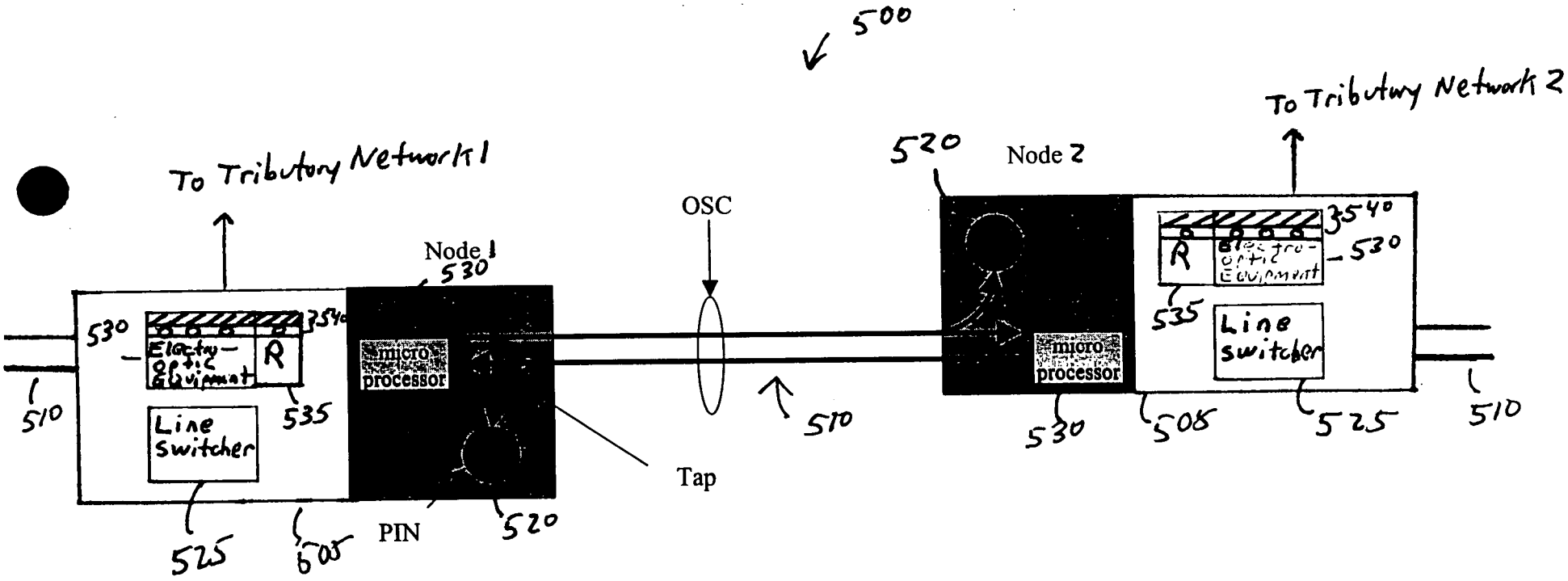
500
To Tributary Network 1
To Tributary Network 2
Node 1
Node 2
OSC
Tap
PIN
micro processor
Line switcher
R
510
520
525
530
535
540
505

FIG. 5

DOCKET NO. 00CN0060

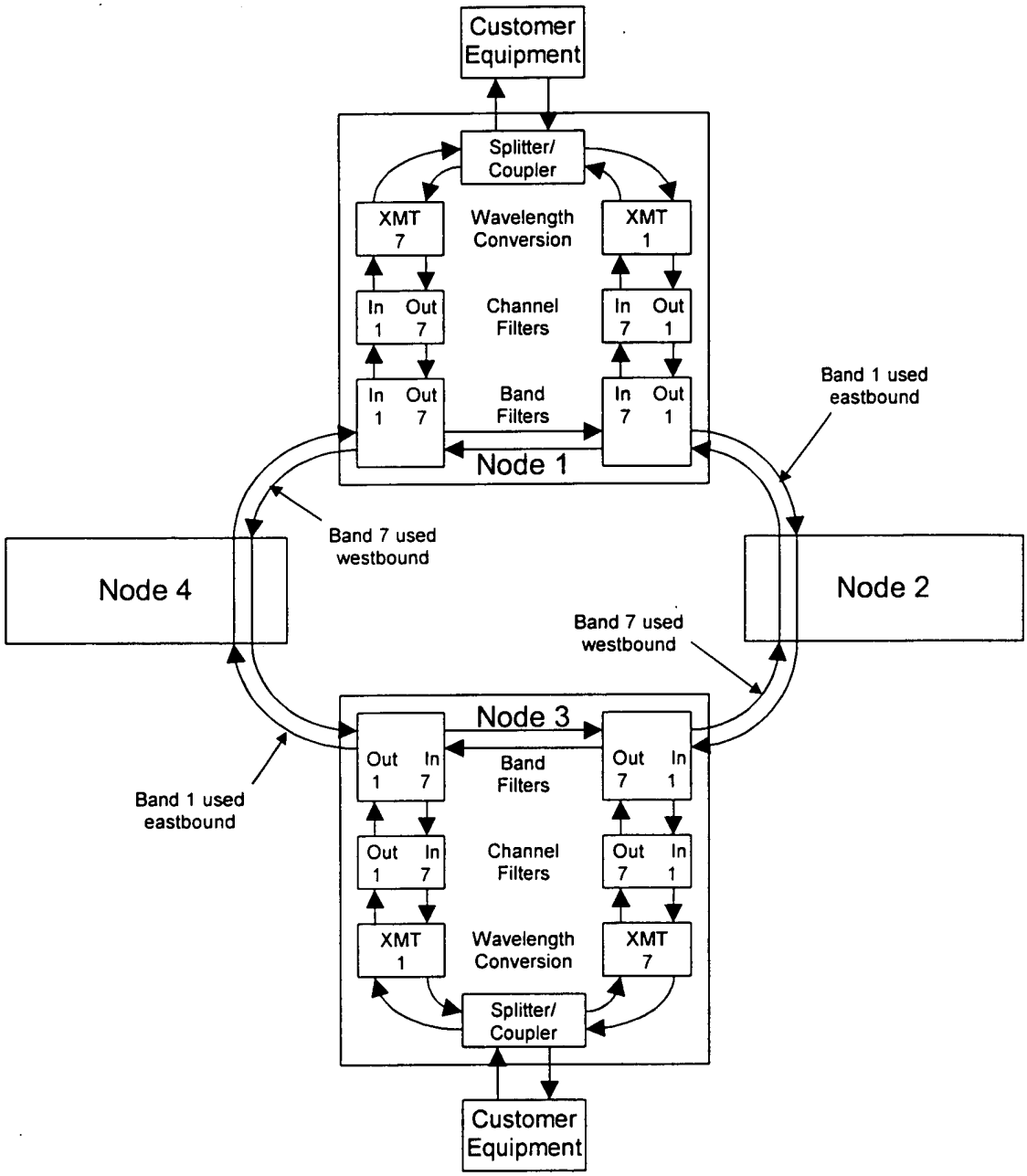

FIG. 6

DOE280 "2984960

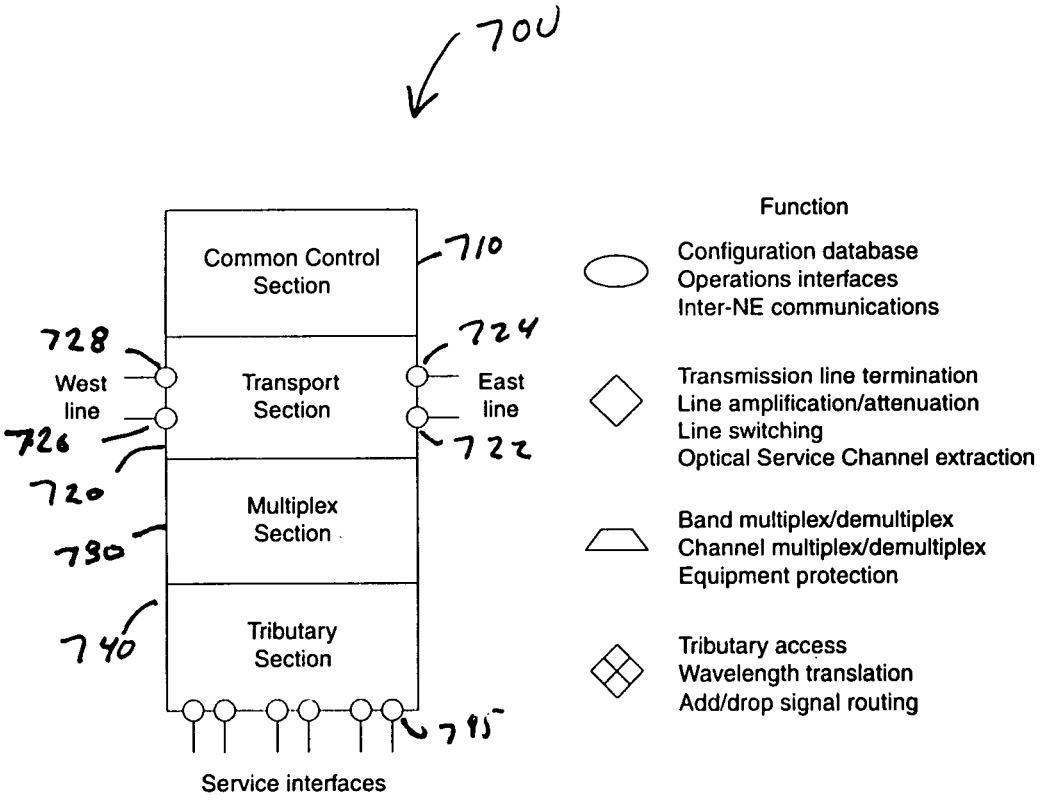

FIG. 7

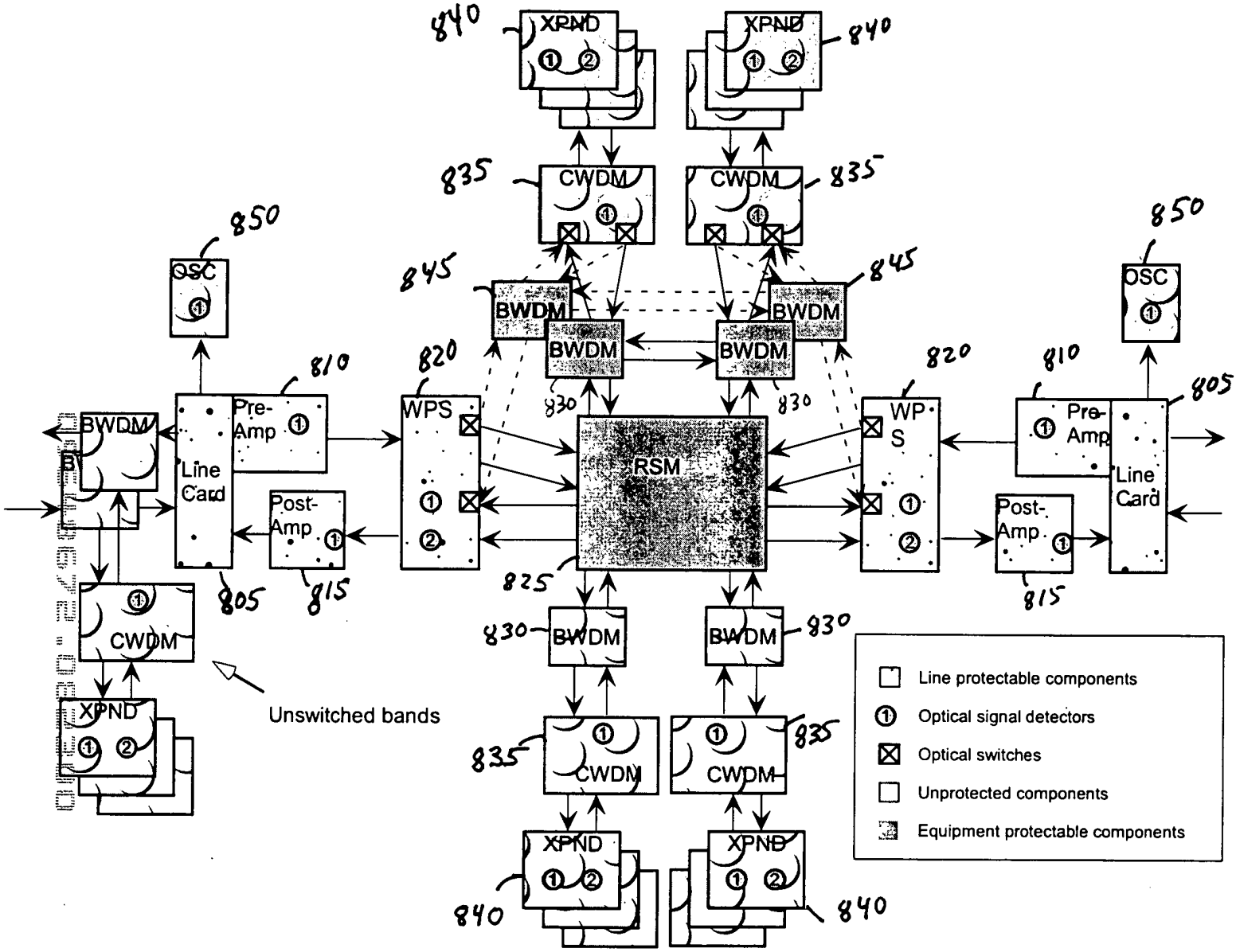
840
XPND
XPND
840
835
CWDM
CWDM
835
850
OSC
845
BWDM
BWDM
BWDM
BWDM
845
850
OSC
820
810
830
830
820
810
805
BWDM
Pre-
Amp
WPS
RSM
WP
S
Pre-
Amp
Line
Card
Line
Card
Post-
Amp
Post-
Amp
805
815
825
815
CWDM
830
BWDM
BWDM
830
Unswitched bands
835
CWDM
CWDM
835
XPND
XPND
840
840
Line protectable components
Optical signal detectors
Optical switches
Unprotected components
Equipment protectable components

FIG. 8

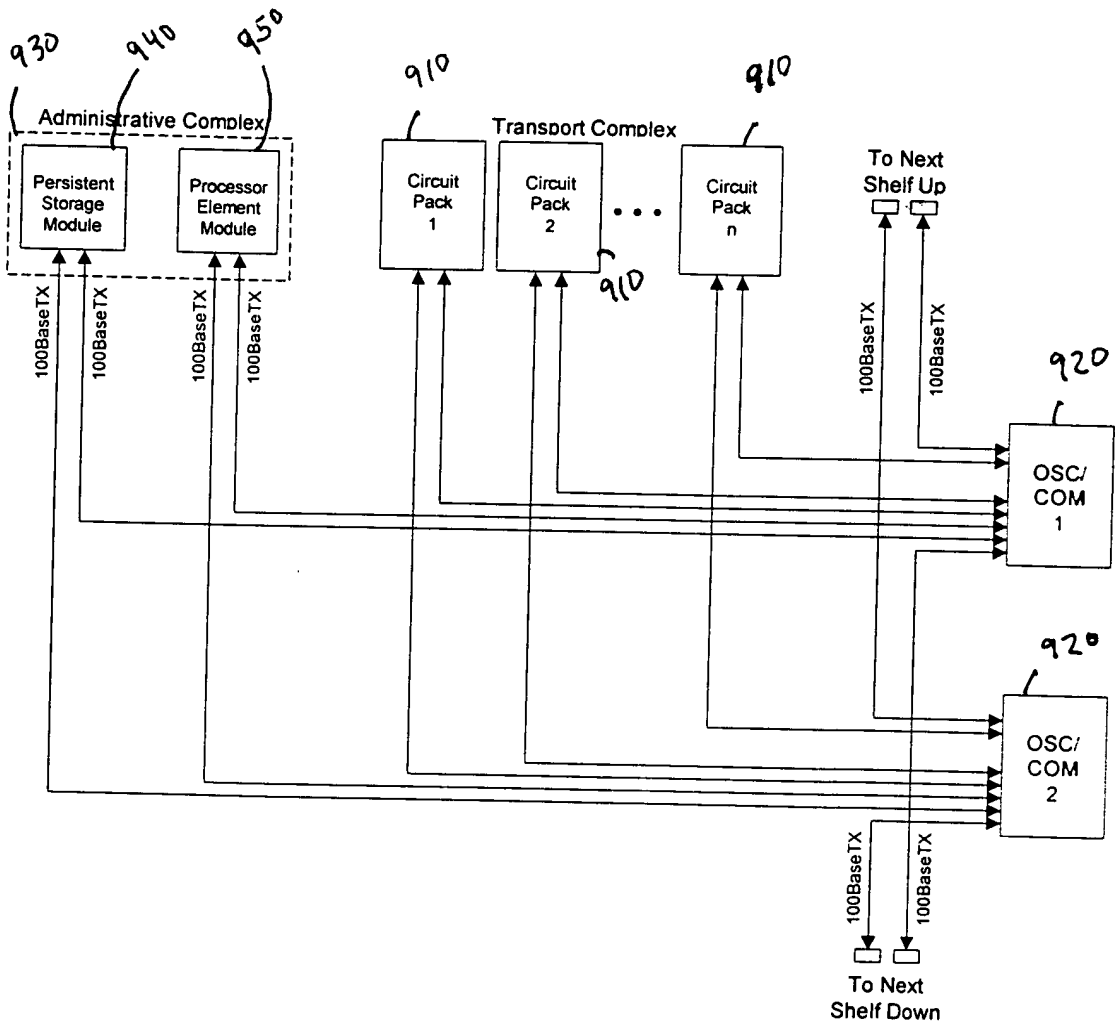
930
940
950
910
910
910
Administrative Complex
Persistent Storage Module
Processor Element Module
Transport Complex
Circuit Pack 1
Circuit Pack 2
Circuit Pack n
To Next Shelf Up
100BaseTX
100BaseTX
100BaseTX
100BaseTX
100BaseTX
100BaseTX
920
OSC/ COM 1
920
OSC/ COM 2
100BaseTX
100BaseTX
To Next Shelf Down

FIG.9

Intra-node Fiber Fault Handling

Legend.
- RS Ring Switch
- DRS Ring Switch Delayed
- EQ Equipment Switch
- DEQ Equipment Switch Delayed
- LOS Loss of Signal at receiver(s)
- ... Indicates a resulting action that does not match the desired action for the failure

Component	Connecting Fibe	Local Node Effec	Downstream Node Effect	Desired Protection Action: Open Node	Desired Protection Action: Passthru Node	Desired Protection Action: Bsame passthru	Desired Protection Action: Bopposite passthru	Desired Protection Action: RSM Glassthru	Node Configurations – WCA without UCA: Open Node	Node Configurations – WCA without UCA: Passthru Node	Node Configurations – WCA without UCA: Bsame passthru	Node Configurations – WCA without UCA: Bopposite passthru	Node Configurations – WCA without UCA: RSM Glassthru	Node Configurations – WCA with UCA: Open Node	Node Configurations – WCA with UCA: Passthru Node	Node Configurations – WCA with UCA: Bsame passthru	Node Configurations – WCA with UCA: Bopposite passthru	Node Configurations – WCA with UCA: RSM Glassthru
Line/ PostAmp	To WPS	Working and PCA drops see LOS	If local node adds traffic, downstream neighbor WPS receive PIN detects light. Otherwise, downstream neighbor WPS receive PIN detects no light. Local passthru channels detect LOS downstream. Local add channels are OK downstream.	RS	RS	RS	RS	RS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	n/a	n/a	n/a	n/a	n/a
	From WPS	No impact	Downstream neighbor WPS receive PIN detects no light. Local passthru or add channels report LOS downstream.	RS	RS	RS	RS	RS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	n/a	n/a	n/a	n/a	n/a
	To Unswitched BWDM	Local working, UCA, and PCA drops see LOS	If local node adds traffic, downstream neighbor WPS receive PIN detects light. Otherwise, downstream neighbor WPS receive PIN detects no light Local passthru channels detect LOS downstream Local add channels are OK downstream.	RS	RS	RS	RS	RS	n/a	n/a	n/a	n/a	n/a	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS
	From Unswitched BWDM	No impact	Downstream neighbor WPS receive PIN detects no light. Local passthru or add channels report LOS downstream.	RS	RS	RS	RS	RS	n/a	n/a	n/a	n/a	n/a	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS	OSC OK WPS IN OK Result: LOS
	To/From OSC	Do not protect against OSC failure – use as ring switch trigger if applicable.																
	To Neighbor	No impact	Downstream neighbor WPS receive PIN detects no light. Local passthru or add channels report LOS downstream.	RS	RS	RS	RS	RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS	Downstream OSC LOS LINE IN LOS Action: RS
	From Neighbor	Local working, UCA, and PCA drops see LOS	If local node adds traffic, downstream neighbor WPS receive PIN detects light. Otherwise, downstream neighbor WPS receive PIN detects no light. Local passthru channels detect LOS downstream Local add channels are OK downstream.	RS	RS	RS	RS	RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS	OSC LOS LINE IN LOS Action: RS
PreAmp	To WPS or Unswitched Band	Working and PCA drops see LOS	If local node adds traffic, downstream neighbor WPS receive PIN detects light. Otherwise, downstream neighbor WPS receive PIN detects no light. Local passthru channels detect LOS downstream. Local add channels are OK downstream.	RS	RS	RS	RS	RS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS	OSC OK WPS IN LOS Result: LOS
	From Line Card	Working and PCA drops see LOS	If local node adds traffic, downstream neighbor WPS receive PIN detects light. Otherwise, downstream neighbor WPS receive PIN detects no light. Local passthru channels detect LOS downstream. Local add channels are OK downstream.	RS	RS	RS	RS	RS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS
WPS	Working from RSM	No impact	Local passthru and add working channels report LOS downstream. PCA channels OK downstream. If local node has protect access traffic, downstream neighbor WPS receive PIN detects light. If no protect access traffic, downstream neighbor WPS receive PIN detects no light.	EQ	EQ	EQ	EQ	EQ	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS
	Protect from RSM (No action taken since protect equipment)	No impact	Local passthru and add PCA channels report LOS downstream.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Working from backup BWDM	No impact	Only detectable if carrying traffic. If equipment switched, local passthru and add channels report LOS downstream. No autorevert to primary.	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

FIG. 10A

	Working to RSM	Local working channel drops see LOS	If local node adds working channels or carries PCA traffic, downstream neighbor WPS receive PIN detects light. Local passthru working channels see LOS downstream. Local add channels are OK downstream.	EQ	EQ	EQ	EQ	EQ	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LIN IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS
	Protect to RSM (No action taken since protect equipment)	Protect access drops see LOS.	Local drop and passthru PCA channels report LOS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
RSM	Working from primary BWDM		Local passthru and add working channels report LOS downstream. PCA channels OK. If local node has PCA downstream neighbor sees light	EQ	EQ	EQ	EQ	EQ	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LIN IN OK Result: LOS	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a
	Protect from BWDM (No action taken since protect equipment)		Local add and passthru PCA channels report LOS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Working to Primary BWDM	Local working channel drops see LOS	If local node adds working channels or carries PCA traffic, downstream neighbor WPS receive PIN detects light. Local passthru working channels see LOS downstream. Local add channels are OK downstream.	EQ	EQ	EQ	EQ	EQ	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LIN IN OK Result: LOS	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a
	Protect to BWDM (No action taken since protect equipment)		Local drop and passthru PCA channels report LOS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
BWDM	To CWDM	Local channel drops see LOS	No impact	EQ (LOS if UCA)	EQ (LOS if UCA)	EQ (LOS if UCA)	EQ (LOS if UCA)	EQ (LOS if UCA)	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a
	From CWDM	No impact	CWDM add channels see downstream LOS. Other add channels and passthru are OK.	EQ (LOS if UCA)	EQ (LOS if UCA)	EQ (LOS if UCA)	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a
	To BWDM (from RSM toward passthru)	Local channel drops downstream of failure see LOS	Passthru working channels see LOS downstream.	EQ	EQ	EQ	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a
	From BWDM (from passthru toward RSM)	No impact	Passthru channels see LOS downstream. Added channels "upstream" of the failure see LOS downstream. Channels added following failure are OK.	EQ	EQ	EQ	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	OSC OK LINE IN OK Result: LOS	n/a	n/a
	To/From BWDM (passthru	No impact	Passthru channels see LOS downstream. Added channels are OK downstream.	n/a	EQ	n/a	n/a	n/a	n/a	OSC OK LINE IN OK Result: LOS	n/a	n/a	n/a	n/a	OSC OK LINE IN OK Result: LOS	n/a	n/a	n/a
WCI	To CWDM	No impact		LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS
	From CWDM	Local LOS		LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS	LOS

FIG. 10B

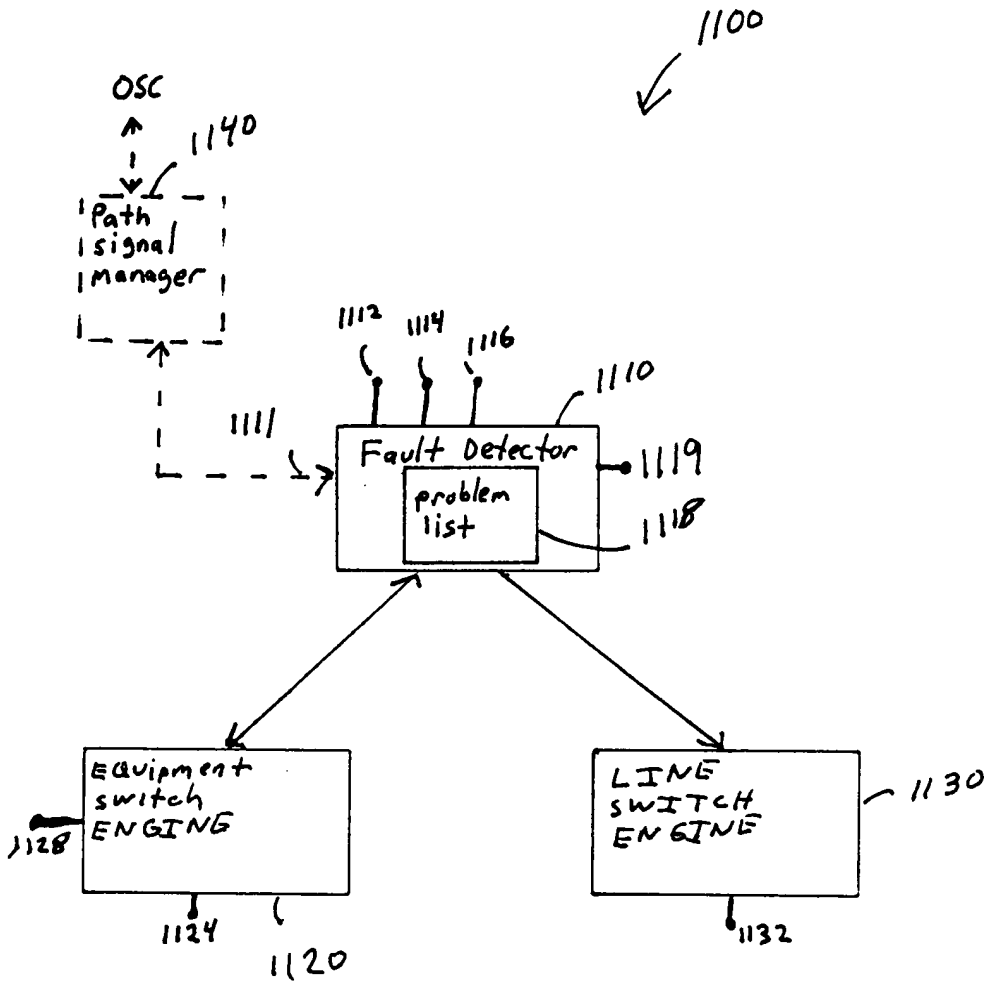
1100
OSC
1140
Path signal manager
1112
1114
1116
1110
1111
Fault Detector
problem list
1119
1118
Equipment switch ENGINE
1128
LINE SWITCH ENGINE
1130
1124
1120
1132

FIG. 11

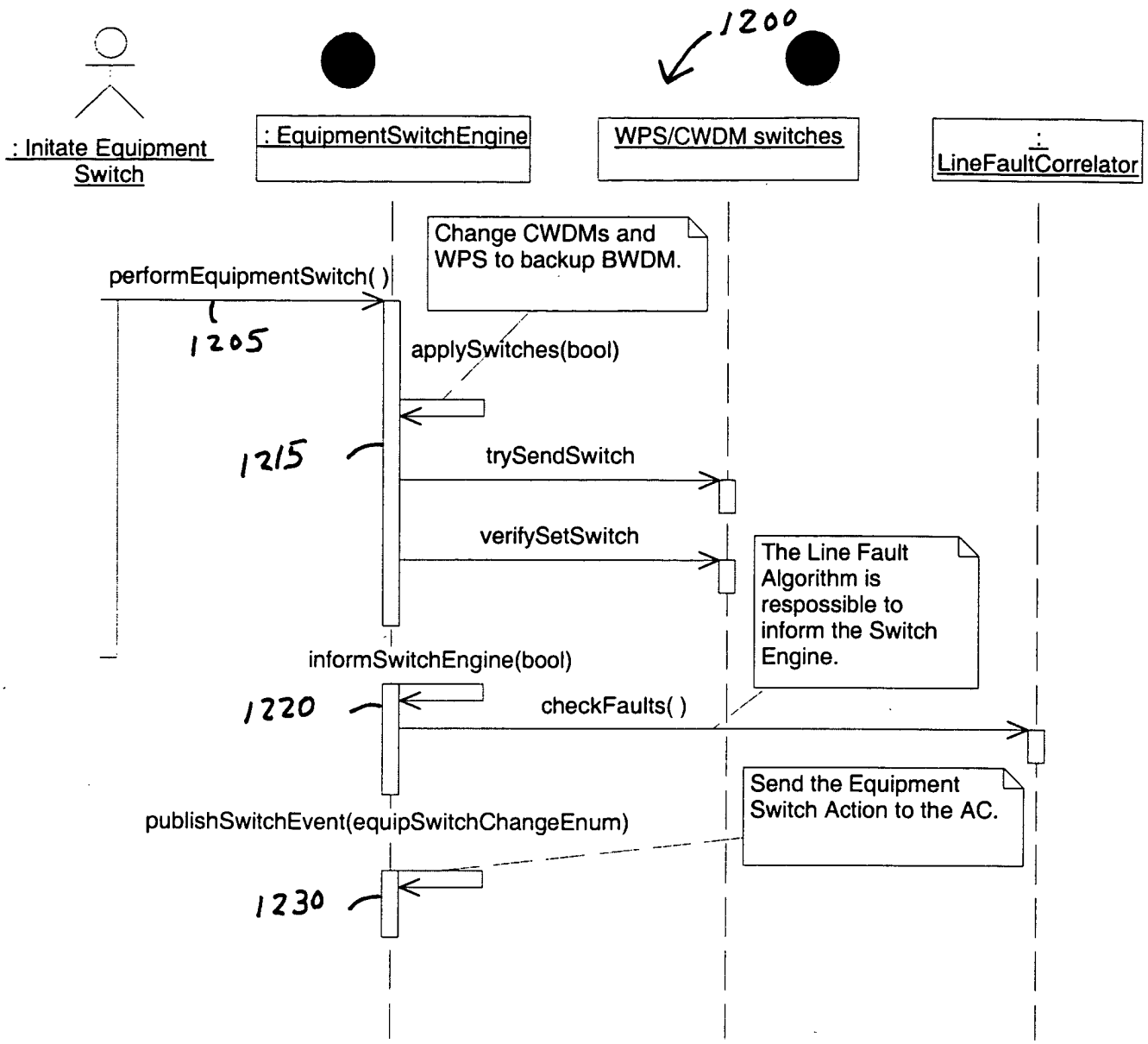
1200
: Initate Equipment Switch
: EquipmentSwitchEngine
WPS/CWDM switches
: LineFaultCorrelator
Change CWDMs and WPS to backup BWDM.
performEquipmentSwitch( )
1205
applySwitches(bool)
1215
trySendSwitch
verifySetSwitch
The Line Fault Algorithm is respossible to inform the Switch Engine.
informSwitchEngine(bool)
1220
checkFaults( )
Send the Equipment Switch Action to the AC.
publishSwitchEvent(equipSwitchChangeEnum)
1230

FIG. 12

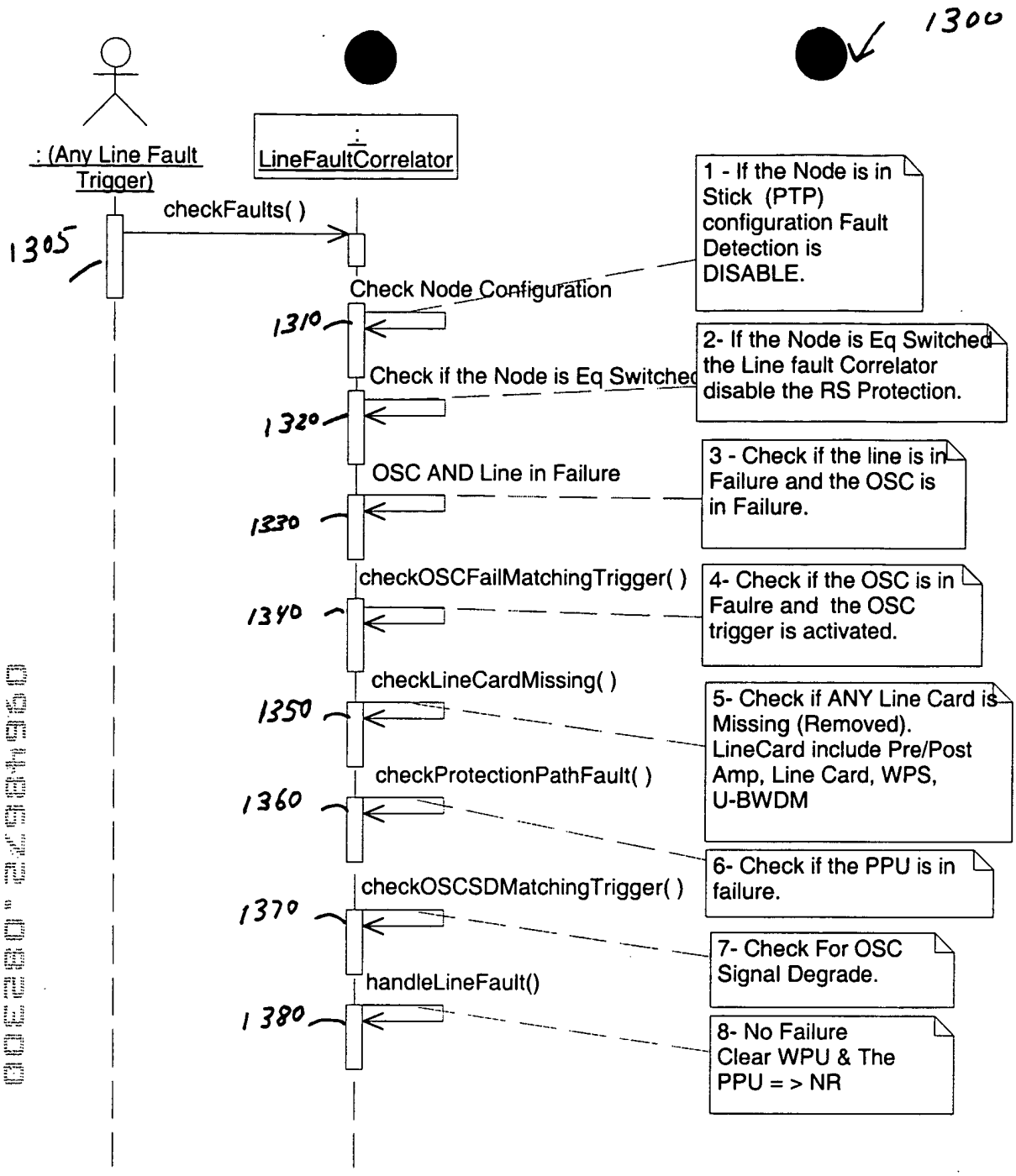
1300
: (Any Line Fault Trigger)
LineFaultCorrelator
checkFaults( )
1305
Check Node Configuration
1310
Check if the Node is Eq Switched
1320
OSC AND Line in Failure
1330
checkOSCFailMatchingTrigger( )
1340
checkLineCardMissing( )
1350
checkProtectionPathFault( )
1360
checkOSCSDMatchingTrigger( )
1370
handleLineFault()
1380
1 - If the Node is in Stick (PTP) configuration Fault Detection is DISABLE.
2- If the Node is Eq Switched the Line fault Correlator disable the RS Protection.
3 - Check if the line is in Failure and the OSC is in Failure.
4- Check if the OSC is in Faulre and the OSC trigger is activated.
5- Check if ANY Line Card is Missing (Removed). LineCard include Pre/Post Amp, Line Card, WPS, U-BWDM
6- Check if the PPU is in failure.
7- Check For OSC Signal Degrade.
8- No Failure Clear WPU & The PPU = > NR

FIG. 13